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Re: Notice of Proposed Rule Making, FCC 02-136, Part II – 135.7–137.8kHz and 160–190kHz Bands (RM9404)

Dear Sirs,

I am an electronics engineer and UK licensed radio amateur (callsign M0BMU), and have been active on the European 135.7–137.8kHz LF amateur band since 1999. In the light of this experience, I make the following comments on the above Notice of Proposed Rule Making with regard to the introduction of a low frequency amateur band in the USA.

Power Limits:

Under UK amateur licence conditions, there is no transmitter power limit, only a 1W ERP (i.e. about 1.6W EIRP) limit on radiated power, for the 135.7–137.8kHz band. It is normal in Europe to use transmitter powers of several hundred watts, and well-equipped amateur stations often use powers of 1-2kW. In spite of this, field strength measurements have shown that the 1W ERP limit is rarely achieved. This is due to the limited height of antennas that can be utilised by amateurs in typical residential locations, and the very low antenna efficiencies that are the inevitable consequence.

Most practical LF antennas behave approximately as electrically short vertical monopoles; with a directivity of 3 compared to an isotropic radiator, and transmitter power of 100W, antenna efficiency of 0.33% would be required to obtain 1W EIRP. Efficiency depends largely on the height of this type of antenna; practical experience indicates that an antenna with supports at least 30m high would be needed to achieve this efficiency at 136kHz. Very few amateurs have been able to use an antenna this large due to the high cost, large amount of real estate required, and planning restrictions. In practice, most amateur LF antennas are less than 20m high, and have efficiencies of the order 0.01% to 0.1%. In these conditions, the maximum radiated power that can be achieved is often limited by electrical breakdown of the antenna, and the 1W ERP limit cannot be reached, even without restriction on transmitter power.

Occasionally, amateurs have resorted to kites and balloons to obtain higher antenna supports, and so more efficient antennas. But there are many practical restrictions on these techniques, such as weather conditions, and safety considerations for bystanders and aircraft, and so use of such techniques is extremely limited.

Therefore, if the proposed 100W PEP transmitter power limit is applied to amateur LF operation in the US, achievable radiated powers for the vast majority of amateurs will be of the order of tens to hundreds of milliwatts, far below the proposed 1W EIRP limit. These levels are extremely small compared to professional radio engineering practice, and operating experience in Europe has shown that even using radiated power levels close to the maximum 1W ERP and the best available techniques, LF communication is marginal due to high noise levels. The proposed US transmitter power limit would therefore be a severe limitation to amateur operation.

Radiated Power Measurement

It has been pointed out in comments by interested parties that radiated power is not easy to measure. A simple estimate of EIRP can be made by measuring the antenna current I_a using thermocouple or rectifier based ammeters, calculating the radiation resistance R_{rad} of the antenna using various simple text book formulae and a knowledge of the antenna geometry, and assuming an appropriate value of directivity D for the antenna type. The EIRP is then $I_a^2R_{rad}D$. As part of my LF amateur radio activities, I conducted an extensive series of field strength measurements to determine the actual EIRP from various antennas. Comparing the values obtained reveals that the simple estimate often produces significant errors, but that the actual EIRP is always lower than the estimated value. This appears to be due to absorption of the propagating signal near the antenna by objects in the surrounding environment. Normally the difference between estimate and measurement is a few decibels, but antennas in urban areas can show a loss of as much as 10dB compared to the estimated value.

Thus although the simple estimation of EIRP is subject to quite large errors, these always result in the estimated radiated power being higher than the true value, and so the estimated values obtained are always conservative (from the regulatory point of view). An amateur using the simple estimate can therefore be confident that his LF signal will be within the permitted radiated power limits.

Interference Potential to PLC and RFID systems

Interested parties have expressed concern about the possibility of 1W EIRP signals from amateur stations interfering with short-range RFID devices and power line communications systems. In Europe, unlike the USA, the LF spectrum is densely populated with utility, government and broadcast transmitters, with EIRP levels in the range from tens to hundreds of kilowatts, and megawatts in the case of some large broadcast stations. Some of these signals are near to, or inside the 135.7–137.8kHz range, and generate much greater field strengths than any feasible amateur station over virtually the whole land area of Europe. In spite of this, LF RFID devices are in widespread use in Europe, and do not appear to be significantly affected by these high ambient signal levels. Similarly, power line communications systems are extensively used in Europe, using various sub-bands in the frequency range 3kHz to 148.5kHz (defined in CENELEC EN50065-1). I am not aware of any reports of interference to the operation of these systems caused by either amateur or professional LF radio signals.

One comment referred to magnetic loop transmitting antennas being employed by amateurs as representing a possible threat to RFID systems – in practice, the vast majority of European amateur LF antennas are of the long-wire type, these types being found to be more efficient and practical in most situations. It was also commented that high levels of harmonics from amateur transmitters could be a problem. In practice, achieving high spectral purity from a LF transmitter is no more difficult than in any other frequency range. Additionally, either electric or magnetic antennas in this frequency range have very narrow bandwidth due to the high Q matching network required – resulting in a high degree of additional suppression of harmonics at the transmitter output.

It would seem that any RFID or PLC device intended for use in international markets outside the USA would have to be engineered to operate with the high ambient LF signal levels present in Europe and other parts of the world. In any case, there currently does not seem to be any significant interference problem where RFID and PLC systems co-exist with LF amateur radio activity.

Conclusions

- The proposed 100W PEP limit on transmitter power would effectively limit the radiated power achievable by the vast majority of amateur stations to much less than the 1W PEP EIRP limit proposal, due to the inherent efficiency limitations of the small antennas used by amateurs. This will severely restrict the capabilities of US LF amateur stations. The experience of European LF amateur radio shows that a much higher transmitter power limit, perhaps of the order of 1kW PEP, would be appropriate to allow the 1W EIRP level to be obtained. Also, it has been found that this level is near the minimum required for successful communications under conditions typical in the LF range.
- Actual measurement of radiated power to ensure compliance with regulations is not easy for amateur stations; however a conservative estimate of radiated power is easily made using a knowledge of the antenna geometry and measurement of the antenna current.
- A 135.7kHz–137.8kHz amateur band has existed in Europe since 1998, with a somewhat higher radiated power limit than that proposed for USA amateur LF operation. There does not appear to have been any significant interference caused by amateur operation to other users of this part of the spectrum, including non-radio services such as RFID or PLC, during this time.

Yours sincerely,

James Moritz, M0BMU